

CLAIMS:

1. A method for cleaning one or more surfaces of an object, the method comprising:

5 spraying a liquid through at least one jet onto at least one surface of at least one object to be cleaned;

10 insonifying the liquid as it is being sprayed so as to produce longitudinal and shear waves which propagates into the object itself with an acoustic transducer so that a frequency and a power of the insonification is kept below a threshold above which cavitation occurs.

2. The method according to claim 1, wherein the liquid being sprayed is insonified so that the acoustic power divided by area (acoustic power/area) is a function of an amount of electric power applied to the acoustic transducer at a given 15 frequency to result in a power density of about 5 kW / cm^2 .

3. The method according to claim 1, wherein the liquid being sprayed is insonified at a frequency greater than or equal to 1MHz.

20 4. The method according to claim 2, wherein the liquid being sprayed is insonified at a frequency greater than or equal to 1MHz.

5. The method according to claim 1, further comprises:

25 moving the object in a direction substantially opposite relative to a direction of the spray so as that any particulates cleaned from the at least one surface are cleaned in a direction opposite the direction in which the object is moving.

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6. The method according to claim 1, further comprises:

moving the jet in a direction substantially opposite to a direction of the spray so as that any particulates cleaned from the at least one surface are cleaned in a direction of the spray.

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7. The method according to claim 1, wherein the step of spraying a liquid includes spraying a liquid at an oblique angle relative to the at least one surface of an object to be cleaned.

10 8. The method according to claim 1, wherein the step of spraying a liquid spray includes spraying a liquid which is de-ionized water.

9. The method according to claim 1, wherein the step of insonifying the liquid includes producing an acoustical wave imparted onto the surface of the one or more objects being cleaned in a directions away from the acoustic transducer.

15 10. The method according to claim 2, wherein the step of moving the object includes moving the object to be cleaned using a conveyor belt.

20 11. The method according to claim 2, wherein the step of spraying a liquid includes spraying a liquid onto at least one surface of at least one object which is made from ceramic.

25 12. The method according to claim 10, wherein the step of spraying a liquid includes spraying a liquid onto at least one surface of at least one object which is made from alumina/TiC.

30 13. The method according to claim 2, wherein the step of spraying a liquid includes spraying a liquid onto at least one surface of at least one object which is a hard disk drive head.

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14. A method for cleaning one or more surfaces of an object, the method comprising:

spraying a liquid through at least one jet onto at least one surface of at least one object to be cleaned;

- 5 insonifying the liquid as it is being sprayed so as to produce longitudinal and shear waves which propagates into the object itself with an acoustic transducer so that a frequency and a power of the insonification is kept below a threshold below which shockwaves occurs.

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15. An apparatus for cleaning objects using insonified liquids comprising:
a carrier for moving one or more objects along a processing assembly line for
cleaning at least one surface of the objects; and
an acoustic transducer with at least one jet for spraying a liquid onto the

5 surface of the objects to be cleaned, wherein the liquid is insonified while it is being
sprayed so that a frequency and a power density of the insonification is kept below a
threshold above which cavitation occurs.

16. The apparatus for cleaning objects according to claim 15, wherein the
10 acoustic transducer provides an acoustic power divided by area (acoustic
power/area) that is a function of an amount of electric power applied to the acoustic
transducer at a given frequency to result in a power density of about 5 kW / cm².

17. The apparatus for cleaning objects according to claim 15, wherein the

15 acoustic transducer is operated at a frequency greater than or equal to 1MHz.

18. The apparatus for cleaning objects according to claim 16, wherein the
acoustic transducer is operated at a frequency greater than or equal to 1MHz.

20 19. The apparatus for cleaning objects according to claim 15, wherein the object
is made from ceramic.

20. The apparatus for cleaning objects according to claim 15, wherein the object
is made from alumina/TiC.

25 21. The apparatus for cleaning objects according to claim 15, wherein the object
is a hard disk drive head (HDDH).

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22. The apparatus for cleaning objects according to claim 15, wherein the object is a hard disk drive head (HDDH) with a plurality of surfaces, and wherein the carrier is configured to be rotatable so at least four surfaces are cleaned by the liquid being sprayed from the jet.

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23. The apparatus for cleaning objects according to claim 15, wherein the carrier comprises two strips of material that are pressed against each of two opposite surfaces of the object allowing access of multiple surfaces to be cleaned by the insonified liquid sprayed from the jet.

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24. The apparatus for cleaning objects according to claim 15, wherein the acoustic transducer is rotatably mounted so that to vary at least one of a longitudinal component and a shear wave component of an acoustic wave produced by the acoustic transducer.

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25. The apparatus for cleaning objects according to claim 15, wherein acoustic transducer is mounted on a robotic arm to permit a direction that the jet for spraying a liquid onto the surface of the one or more objects to be adjusted relative to the surface of the one or more objects.

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26. An apparatus for cleaning objects using insonified liquids comprising:
a carrier for moving one or more objects along a processing assembly line for
cleaning at least one surface of the objects; and
an acoustic transducer with at least one jet for spraying a liquid onto the
surface of the objects to be cleaned, wherein the liquid is insonified while it is being
sprayed so that a frequency and a power density of the insonification is kept below a
threshold below which shock waves occurs.
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